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Introduction:
Brain-computer interface (BCI) is a potential tool for rehabilitation and communication. Most of the BCI experiments relies on the electroencephalography (EEG). Despite its clinical applications, BCI faces to both engineering and user-oriented challenges to improve its spreading. In this work, we assess the possibility of integrating electroencephalographic (EEG) and magnetoencephalographic (MEG) signals to enhance the classification performance in motor imagery-based BCI.

Material, Methods and Results:
We performed an offline classification from a dataset which gathers simultaneously recorded M/EEG signals from 15 healthy subjects (aged 28.13±4.10 years, 7 women). We used the one-dimensional two-target box-tasks experiment in which the subjects imagined a movement with the right hand or remained at rest, depending on the position of the target. During the first 5 runs, only the target was displayed (training phase) followed by 6 runs with a provided feedback (testing phase).
For each modality (EEG, magnetometers -MAG and gradiometers -GRAD), we extracted the relevant features from training recordings. Then, we performed a classification of the testing data by integrating the classifiers' output from each modality via the Bayesian fusion approach, in which contribution of each modality is modulated via an attributed weight computed from the associated posterior probability. To compare classification performances between the fusion and the single-modality approach, the classification accuracy was estimated with the area under the curve (AUC).
Significant changes of event-related de/synchronization appeared in alpha and beta band in all modalities. Results show that modality significantly affects the classification performance (ANOVA, $p<0.001$). Averages of 0.58±0.07, 0.58±0.09, 0.61±0.10, and 0.66±0.11 were obtained with EEG, MAG, GRAD and fusion classifiers respectively. In 13 subjects, the fusion led to an improvement of the AUC in comparison with single-modality approach, with relative increments ranging from 1.3% to 50.9%.

Discussion:
By using a rather simple classifier, we could include a reduced number of specific features involved in the motor-related neural mechanisms such as ERD in alpha and beta bands. More sophisticated approaches using the whole feature space, such as support vector machines and Riemannian geometry as well as alternative fusion strategies, but also classification in source space to improve spatial resolution, can be further evaluated.
Significance: The proposed fusion method led, in a large majority of subjects, to a reduction in the subjects' mental state misclassifications. Our weighting approach enabled to adapt the modality choice according to the subject and the session. Current searches focused on MEG sensors miniaturization will probably enable a larger diffusion of the integration of M/EEG features to further enhance BCIs performances.